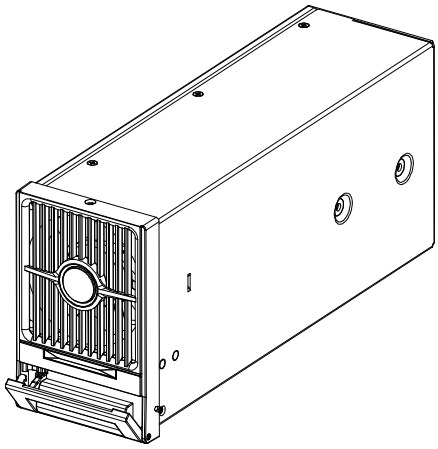
A technical manual from the experts in *Business-Critical Continuity*™

NetSure™ Rectifier Module

User Instructions

UM1R483500E (Issue AG, November 20, 2012)

SPEC. NOS.	MODELS
1R483200	R48-3200
1R483200E	R48-3200E
1R483500E	R48-3500E



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INTRODUCTION

Overview

The Rectifiers provide load power, battery float current, and battery recharge current during normal operating conditions. The Rectifiers are a constant power design. The Rectifiers are rated at their maximum output power. This means that, within the normal operating ambient temperature range and input voltage range, the maximum available output power is a constant 3200W or 3500W (depending on Rectifier model). Within these ranges, the Rectifiers operate in one of three modes, depending upon load demands. Transition between modes is completely automatic. If ambient temperature rises above or input voltage falls below acceptable values, Rectifiers continue to operate but at derated output power levels.

- **Constant Voltage Mode:** For any initial output voltage setting from 42 to 58 volts, output voltage remains constant regardless of load. This is the normal operating condition, in which loads are being supplied and batteries are float charged. Rectifiers operate in the Constant Voltage Mode unless load increases to the point where the product of load current and output voltage is approximately 3200W or 3500W (depending on Rectifier model).
- **Constant Power Mode:** As load increases above approximately 3200W or 3500W (depending on Rectifier model) (non-adjustable), output current continues to increase, but output voltage decreases as required to maintain constant output power. Rectifiers operate in the Constant Power Mode unless load continues to increase to the point where the current limit setting is reached.
- **Constant Current Mode:** If load increases to the current limit setting, output voltage decreases linearly to maintain output current at the current limit setting.

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Specifications

DC Output Ratings

- **Voltage:** Nominal -48.0 VDC, Positive Ground.
  - **a) Adjustment Range:** The output voltage can be set within the range of -42V to -58V, adjustable via the Controller.
- **Output Power and Current:**
  - **a) Spec. No. 1R483200, Model R48-3200 and Spec. No. 1R483200E, Model R48-3200E:** 3200W, maximum (55.2A @ -58 VDC to 66.6A @ -48 VDC).
  - **b) Spec. No. 1R483500E, Model R48-3500E:** 3500W, maximum (60.3A @ -58 VDC to 72.9A @ -48 VDC).
- **Output Characteristics:**
  - **a)** Refer to Figure 1, Figure 2, and Figure 3 for graphs of rectifier output voltage vs. output current.

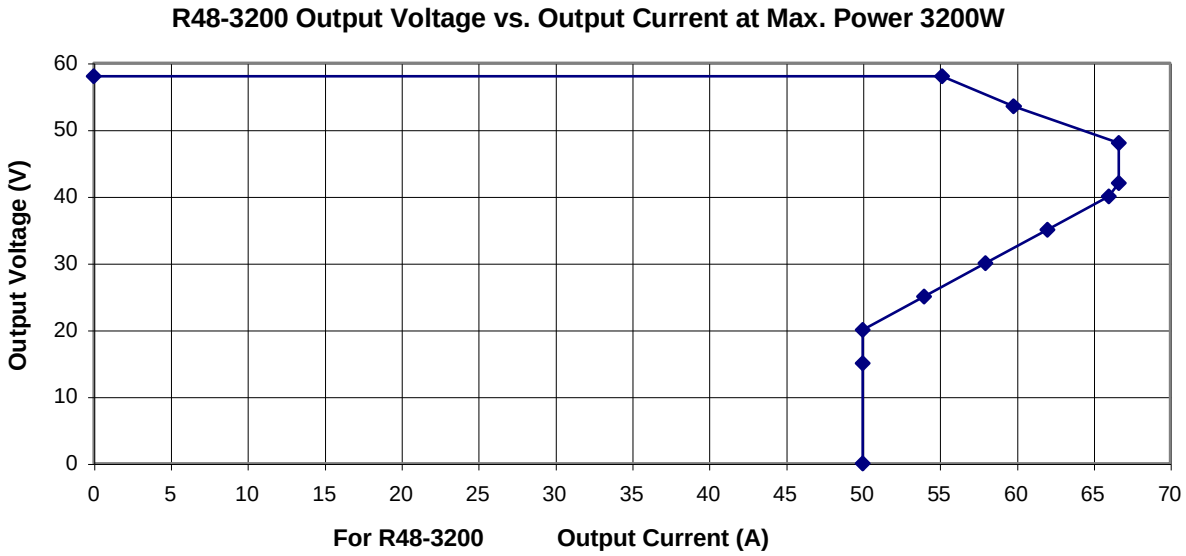

Figure 1
Output Voltage vs. Output Current [R48-3200 (1R483200)]

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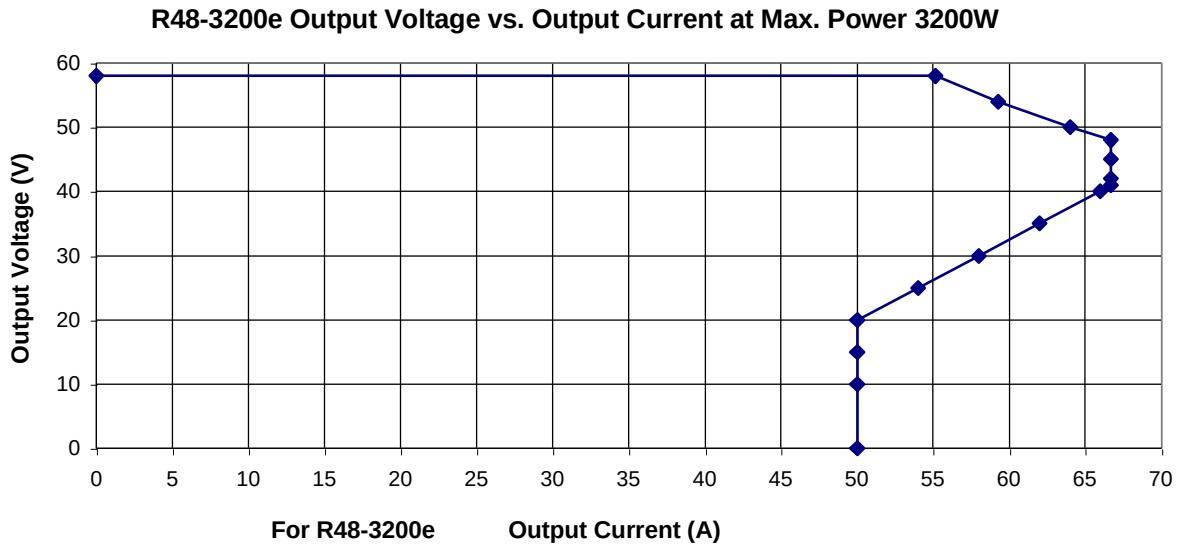

Figure 2
Output Voltage vs. Output Current [R48-3200E (1R483200E)]

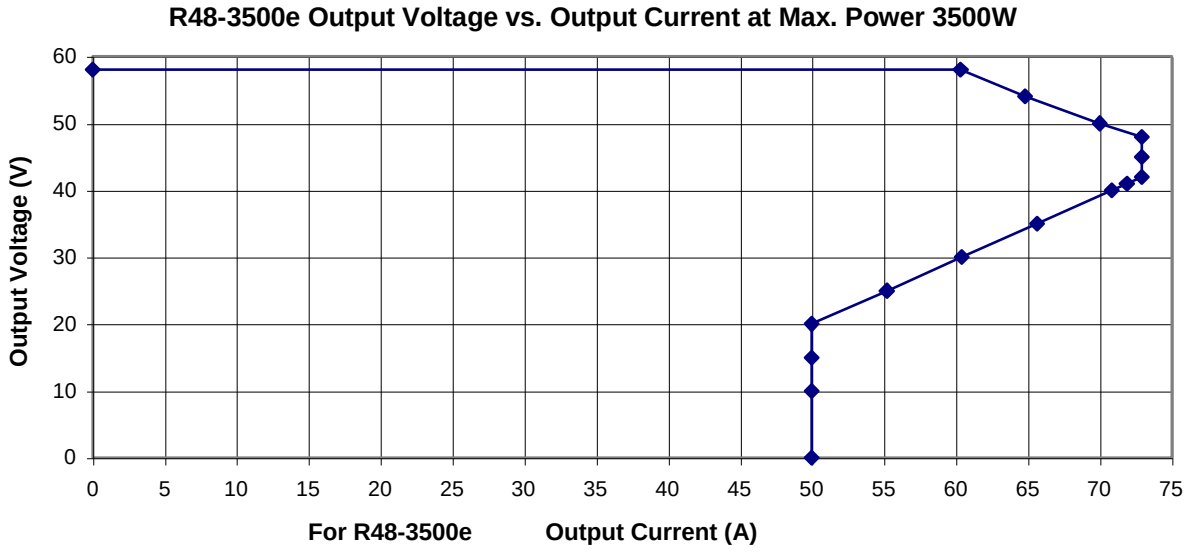

Figure 3
Output Voltage vs. Output Current [R48-3500E (1R483500E)]

- **Power Derating Based on Input Voltage:**
  - **a) R48-3200 (1R483200):** See Figure 4.
  - **b) R48-3200E (1R483200E):** See Figure 5.
  - **c) R48-3500E (1R483500E):** See Figure 6.

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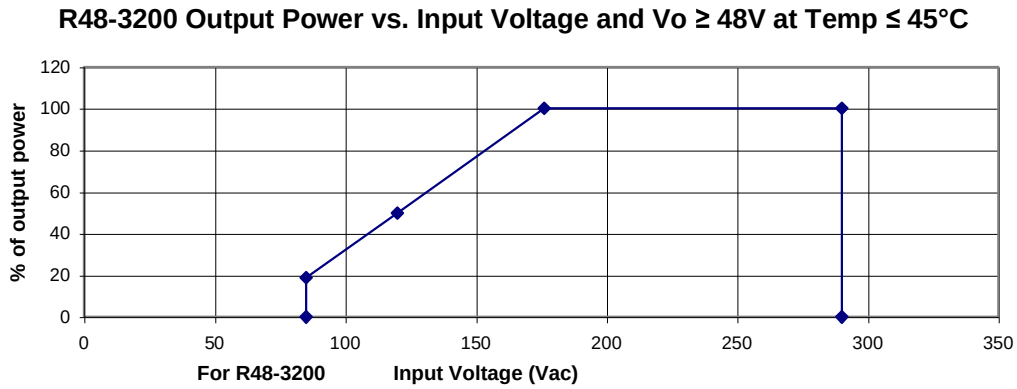

Figure 4
Power Derating Based on Input Voltage (R48-3200 [1R483200])

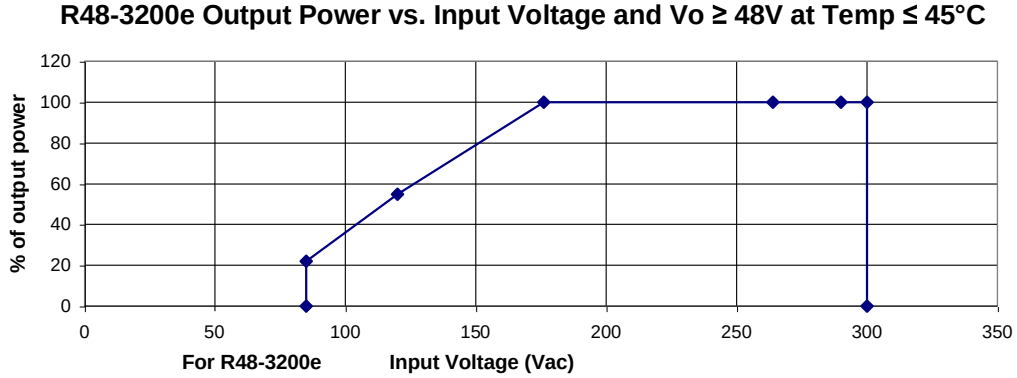

Figure 5
Power Derating Based on Input Voltage (R48-3200E [1R483200E])

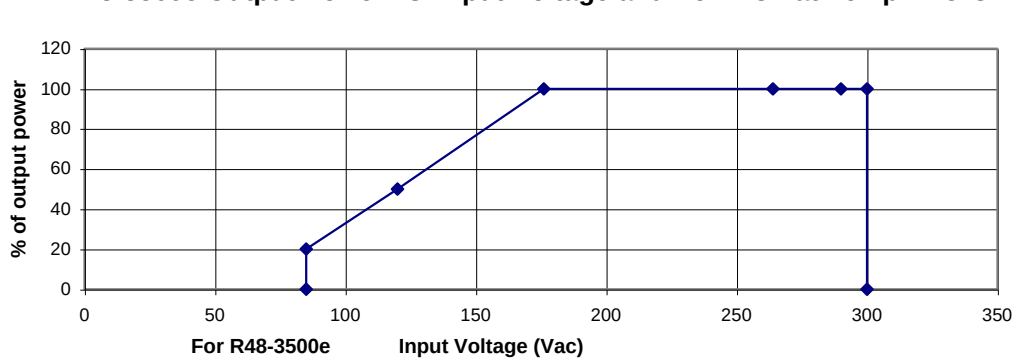

Figure 6
Power Derating Based on Input Voltage (R48-3500E [1R483500E])

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- **Power Derating Based on Temperature:** The Rectifier delivers full power when operating at an ambient temperature of +45°C (+113°F) or below. Each Rectifier continuously monitors the ambient temperature surrounding the power conversion circuit. If this temperature for any reason (such as a high ambient temperature or failed fan) increases above approximately +45°C (+113°F), the Rectifier will not shut down. Rather, the Rectifier limits its maximum output power to maintain the temperature of the power conversion circuit within design parameters. Operation between +45°C (+113°F) and +75°C (+158°F) will result in output power being decreased. Full power capability is restored when the temperature decreases to below approximately +45°C (+113°F). Refer to Figure 7, Figure 8, and Figure 9 to view the relationship between the output power and the ambient temperature.

  1) Rectifiers 1R483200 and 1R483200E provide a minimum of 2320 watts at 65°C and from 48.0 to 58.0VDC.

  2) Rectifier 1R483500E provides a minimum of 2700 watts at 65°C and from 48.0 to 58.0VDC.

Warning: ***The module is rated for continuous operation at full output power up to +45°C (+113°F). Operation between +45°C (+113°F) and +75°C (158°F) will result in output power decrease. Operation above +75°C (+158°F) is considered abnormal and should be used on a temporary[1] basis only.***

[1] **Temporary Operation at Abnormal Temperature:** Temporary operation is defined as a period of not more than eight consecutive hours per day, and a total of not more than 15 days in a year. (This refers to a total of 120 hours in any given year, but no more than 15 occurrences in that one-year period.)

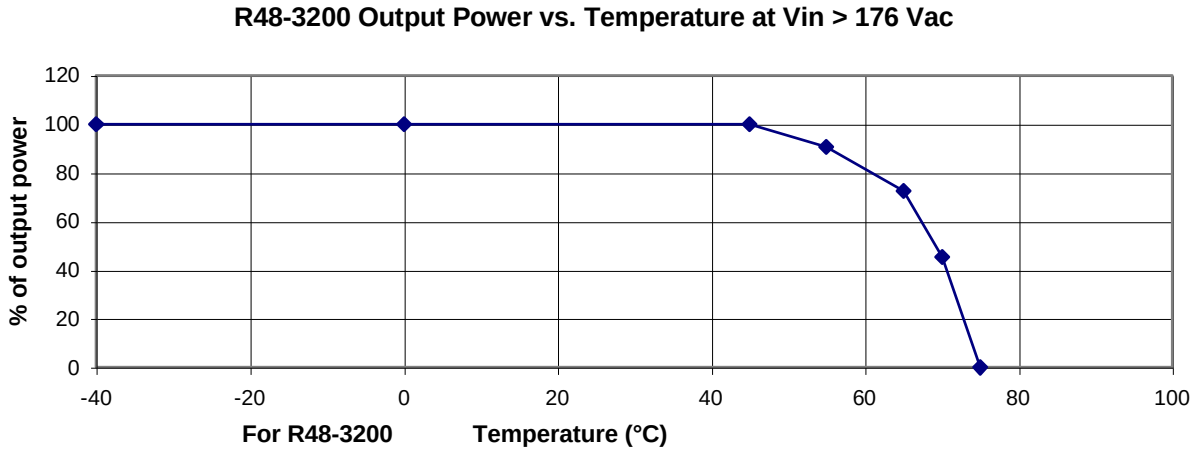

Figure 7
Typical Thermal Power Limit Curve (R48-3200 [1R483200])

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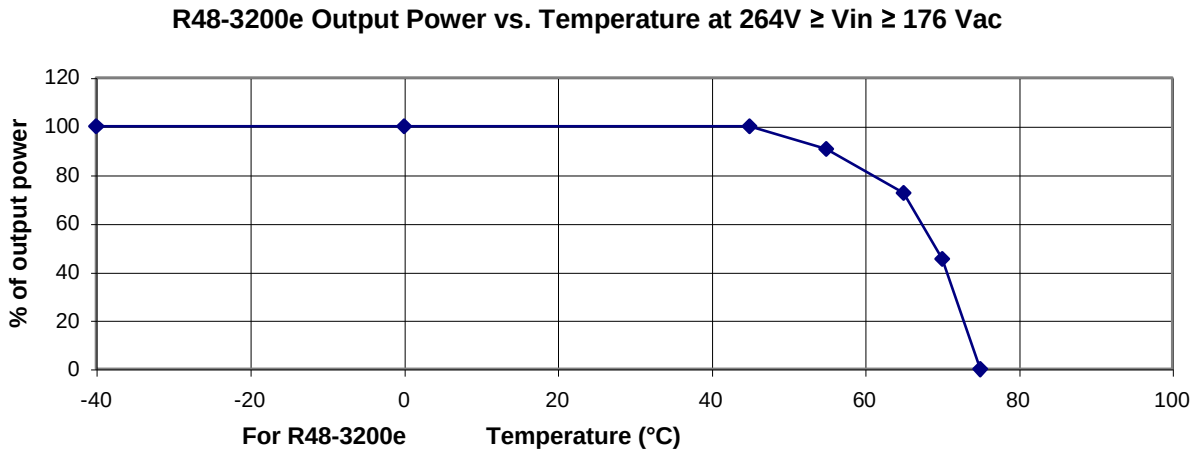

Figure 8
Typical Thermal Power Limit Curve (R48-3200E [1R483200E])

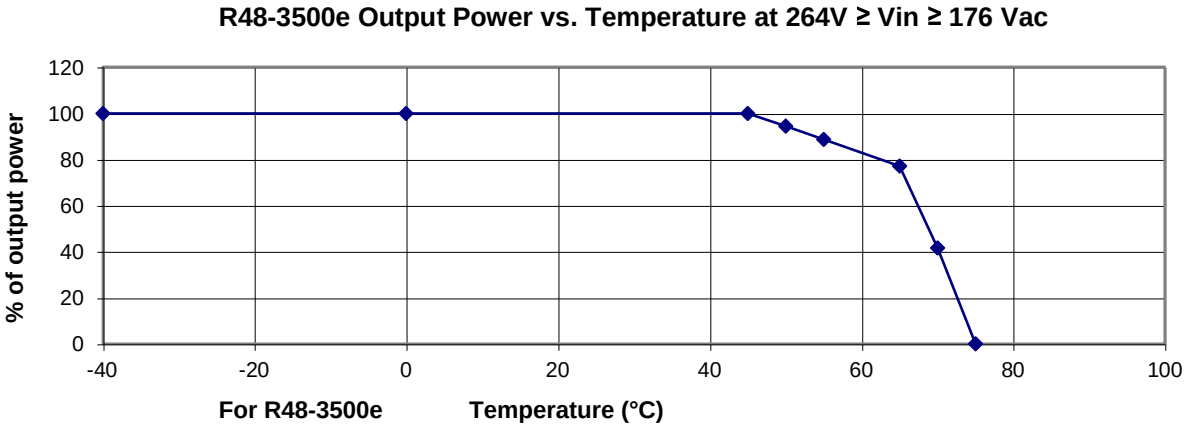

Figure 9
Typical Thermal Power Limit Curve (R48-3500E [1R483500E])

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- **Regulation:**

  a) Output Voltage Tolerance:

  Output voltage tolerance:
  < ± 0.2% 25A load +15°C - +35°C
  < ± 0.5% 25A load -5°C - +55°C

  Static regulation, including input voltage variation and temperature variation:
  < ± 0.5% 5-100% load +15°C - +35°C
  < ± 1% 5-100% load -5°C - +55°C

  Uin = 176-290 Vac, f = 45 Hz - 65 Hz

  Output voltage decreases with increased output current.

  Overshoot of output voltage at startup ≤ ±1%.

  b) Dynamic Response Characteristic (at rated input and output voltage):

  Response time ≤ 200us and overshoot ≤ 5% for load changes at 50% - 25% - 50% and 50% - 75% - 50%.

  Overshoot or undershoot ≤ 5% and output recovers within ±1% of regulation band in ≤ 4ms for load changes at 10% - 90% and 90% - 10%. (Telcordia GR-947.)

- **Filtering (with or without battery):**

  a) Voice Band Noise: Complies with Telcordia GR-947-CORE.

  1) Output noise according to Telcordia GR-947-CORE: < 32dBrnC between 180V~290Vac input and 10 - 100% load (output voltage > 42V, for any application with > 1 Rectifier).

  2) Psophometric noise is ≤ 1mV between 180V~290Vac input and 10 -100% load (output voltage > 42V) and 16.66-6000Hz. (for any application with > 1 Rectifier).

  b) Wide Band Noise: Complies with Telcordia GR-947-CORE.

  1) Typically 130 millivolt peak-to-peak. Does not exceed 250 millivolt peak-to-peak.

  2) Typically 13 millivolts rms. Does not exceed 30 millivolt rms.

- **Output Discharge:** The output capacitors automatically discharge when the Rectifier is disconnected from the batteries and AC is turned OFF. Time constant is less than 1 minute.

- **Power Interruption:** The Rectifier starts when connected to a fully discharged battery or capacitor bank (bus voltage > 15V) without operating protective devices or requiring the shedding of load or needing any manual intervention. The Rectifier starts under all line and environmental conditions, when the output terminals are connected to an impedance of less than 15 milliohms.

- **Stability Criteria:** Complies with GR947 Core R3-20. Stability criteria: > 30 deg. of phase margin when gain is unity (0 dB) and gain down to < - 6 dB when phase is 180 deg.

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AC Input Ratings

- **Voltage:** Nominal 208/240 volts AC, single phase, 50/60 Hz, with an operating range of 176 to 264 volts. Acceptable input frequency range is 45 to 65 Hz.

  Safe Voltage: The system can tolerate 415 volts AC without damage.

- **Harmonic Content (THD):** < 5% THD at 50% - 100% load. The voltage source must have a voltage THD of < 1.1%.

  The Rectifier complies with EN61000-3-2.

- **Inrush Current:** Peak does not exceed 1.5 times the steady state peak value of the input current at full load, nominal input voltage, and for any duration of AC input interrupts. Under the above conditions, standard AC distribution circuit breakers will not trip.

- **Typical Input Data (1R483200):** 60 Hz input.

  a) System output is initially adjusted to 54.48 volts DC as measured at the system sense points at 50% of full load and nominal input. "Percent of Full Load" refers to percent of 55 Amperes.

Nominal Input Voltage	Percent of Full Load	Input Current (Amperes)	Input VA	Input Watts	Power Factor %	Efficiency %	Heat Dissipation BTU/Hr
208	0	0.62	127	69	54.2	--	235.25
	25	4.13	856	842	98.8	88.9	319.31
	50	7.92	1644	1639	99.7	91.0	479.51
	75	11.87	2457	2453	99.8	91.6	701.88
	100	16.02	3298	3297	99.8	90.9	1020.09
	110	17.28	3561	3558	99.8	90.5	1156.27
	120	16.88	3478	3477	99.8	89.9	1208.42
240	0	0.68	163	66	61.2	--	225.31
	25	3.65	865	846	97.7	88.7	325.42
	50	6.89	1648	1633	99.4	91.9	453.62
	75	10.23	2445	2441	99.8	92.1	654.78
	100	13.68	3269	3265	99.8	91.8	917.81
	110	14.84	3538	3534	99.8	91.3	1050.24
	120	14.46	3455	3454	99.8	90.5	1118.21

b) **Maximum Input Current:** at 100% of full load with output adjusted to 58 volts DC as measured at the shelf output terminals.

Nominal Input Voltage	Input Voltage	Input Current (Amperes)
208/240	176	20.42

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- **Typical Input Data (1R483200E):** 60 Hz input.

  a) System output is initially adjusted to 54.48 volts DC as measured at the system sense points at 50% of full load and nominal input. "Percent of Full Load" refers to percent of 55 Amperes.

Nominal Input Voltage	Percent of Full Load	Input Current (Amperes)	Input VA	Input Watts	Power Factor %	Efficiency %	Heat Dissipation BTU/Hr
208	0	0.42	89	11	12.2	--	36.53
	25	3.80	798	782	98.0	95.71	114.64
	50	7.42	1553	1547	99.6	96.62	178.38
	75	11.18	2334	2331	99.8	96.31	293.16
	100	15.20	3166	3164	99.9	95.64	471.10
	110	16.36	3406	3406	99.9	95.54	518.52
	120	16.28	3424	3422	99.9	95.00	583.64
240	0	0.50	121	10	8.80	--	35.67
	25	3.33	806	780	96.8	95.90	109.19
	50	6.44	1556	1543	99.1	96.84	166.43
	75	9.77	2356	2349	99.7	96.63	270.25
	100	12.86	3094	3089	99.8	96.19	401.59
	110	14.08	3395	3386	99.8	96.05	456.47
	120	14.06	3398	3394	99.8	95.35	539.14

b) **Maximum Input Current:** at 100% of full load with output adjusted to 58 volts DC as measured at the shelf output terminals.

Nominal Input Voltage	Input Voltage	Input Current (Amperes)
208/240	176	19.30

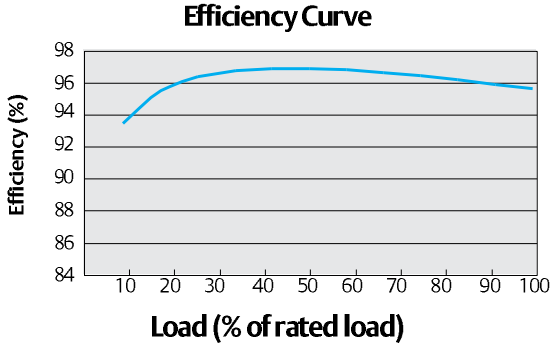

Figure 10
Efficiency Curve [R48-3200E (1R483200E)]

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- **Typical Input Data (1R483500E):** 60 Hz input.

  a) System output is initially adjusted to 54.48 volts DC as measured at the system sense points at 50% of full load and nominal input. "Percent of Full Load" refers to percent of 60 Amperes.

Nominal Input Voltage	Percent of Full Load	Input Current (Amperes)	Input VA	Input Watts	Power Factor %	Efficiency %	Heat Dissipation BTU/Hr
208	0	0.42	87	11	12.5	--	34.5
	25	4.20	872	853	97.7	95.28	132.7
	50	8.20	1700	1690	99.4	96.00	221.2
	75	12.34	2553	2546	99.7	95.48	378.6
	100	16.66	3441	3435	99.8	94.31	651.1
	110	18.32	3781	3775	99.8	93.68	800.1
	120	18.36	3790	3782	99.8	93.29	854.6
240	0	0.49	118	11	9.2	--	34.2
	25	3.66	877	850	96.9	95.59	123.2
	50	7.11	1704	1684	98.8	96.34	201.0
	75	10.65	2547	2535	99.5	95.86	343.9
	100	14.34	3423	3414	99.7	94.90	576.4
	110	15.75	3758	3748	99.7	94.36	703.8
	120	15.79	3768	3757	99.7	93.91	765.4

b) **Maximum Input Current:** at 100% of full load with output adjusted to 58 volts DC as measured at the shelf output terminals.

Nominal Input Voltage	Input Voltage	Input Current (Amperes)
208/240	176	21.60

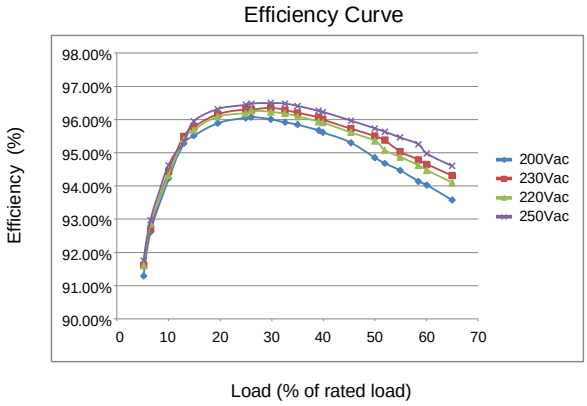

Figure 11
Efficiency Curve [R48-3500E (1R483500E)]

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Environmental Ratings

- **Operating Ambient Temperature Range:**

  a) -40°C (-40°F) to +75°C (+167°F) with derating output.

  b) -40°C (-40°F) to +45°C (+113°F) with full power performance.

  c) Temperature Coefficient:
  0.01% per degrees Celsius.

- **Storage Ambient Temperature Range:** -40°C (-40°F) to 75°C (+167°F).
- **Relative Humidity:** This Rectifier is capable of operating in an ambient relative humidity range of 0% to 95%, non-condensing.
- **Altitude:** 2000 m (6560 ft) at full power (power limited for heights above 2000 m).
- **Surge Protection:** Compliance with EN61000-4-5 Installation Class 4, and capable of withstanding surges per ANSI/IEEE C 62.41 1999 Category B3 across the input terminals.

  Note: *This level of protection is a widely used standard for telecommunications power equipment. As with all such equipment, it is the end user's responsibility to provide an adequately sized Surge Suppression Device at the commercial power service entrance of the building that reduces all incoming surges to levels below the classes/categories stated for the equipment.*

- **Ventilation Requirements:** The Rectifiers are fan cooled and utilize front to back forced ventilation. A Rectifier must be mounted so ventilating openings are not blocked and temperature of the air entering the Rectifier does not exceed the Operating Ambient Temperature Range stated above.
- **Single Rectifier Audible Noise:**

  a) At 25°C ≤ 53dB(A) with fan in high speed; Measurement made at 0.6m distance in front of Rectifier and at same horizontal line of the middle of Rectifier.

  b) At 25°C ≤ 45dB(A) with fan in low speed; Measurement made at 1m distance in front of Rectifier and at same horizontal line of the middle of Rectifier.

- **EMI/RFI Suppression:**

  a) Rectifiers operating in an approved Rectifier Mounting Shelf conform to the requirements of FCC rules Part 15, Subpart B, Class B for Radiated and Conducted emissions limits.

  b) Rectifiers operating in an approved Rectifier Mounting Shelf conform to the requirements of European Norm, EN55022, Class B for Radiated and Conducted emissions limits.

Compliance Information:

a) Safety Compliance: This unit meets the requirements of UL 60950-1, Standard for Information Technology Equipment, and is UL Recognized as a power supply for use in Telephone, Electronic Data Processing or Information Processing Equipment. This unit meets the requirements of CAN/CSA 22.2, No. 60950-00 and is tested and Certified by UL ("c UR")as a Component Type Power Supply.

b) The Rectifiers are RoHS compliant, 5/6.

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Standard Features

- **Type of Power Conversion Circuit:** High frequency.
- **Constant Voltage Mode:** For any initial output voltage setting from 47 to 58 volts, output voltage remains constant regardless of load. This is the normal operating condition, in which loads are being supplied and batteries are float charged. Rectifiers operate in the Constant Voltage Mode unless load increases to the point where the product of load current and output voltage is approximately 3200W or 3500W (depending on Rectifier model).
- **Constant Power Mode:** As load increases above approximately 3200W or 3500W (depending on Rectifier model) (non-adjustable), output current continues to increase, but output voltage decreases as required to maintain constant output power. Rectifiers operate in the Constant Power Mode unless load continues to increase to the point where the current limit setting is reached.
- **Constant Current Mode:** If load increases to the current limit setting, output voltage decreases linearly to maintain output current at the current limit setting.
- **Input Protection:**
  - **a) Fuse:** On the input, two UL recognized fuses are used, not user-replaceable.
  - **b) Input Voltage Protection:** Operating range is 85-290Vac. Derating from 85Vac to 176Vac. Withstand 415Vac input w/o damage.
    - **1)** The Rectifier will shut down at low or high voltage input; Low voltage disable point: 80V±3V; Hysteresis at least 15 VAC for restart. High voltage disable point: 295V±5V; Hysteresis at least 10 VAC for restart.
    - **2)** Between 85V and 176V the output power will be derated linearly according to input voltage per Figure 4, Figure 5, and Figure 6.
    - **3)** Over Voltage Isolation: The Rectifier will be disconnected from the AC input when a preset non-adjustable value is reached.
- **AC Fail Alarm:** The Rectifier issues an "AC Fail Alarm" when AC input voltage drops below 164Vac. This alarm clears when AC input voltage recovers above 169Vac.
- **Output Protection:**
  - **a) Overload / Reverse Current:** An output fuse is provided on each Rectifier. This fuse is not customer replaceable. The Rectifier can be plugged into or pulled out of a shelf while operating, without damage or opening the fuse.
  - **b) Current Limiting:** The maximum current delivered by the rectifier can be set via the Controller from 10% to 121% of its rating at maximum rated output voltage. Output Current Limit Error: ≤ ±1.5A.
  - **c) High Voltage Shutdown:**
    - **1) Internal:** If Rectifier output voltage exceeds an adjustable preset value and it is delivering more than 10% of its rated current, the Rectifier shuts down. After approximately 6 seconds, the Rectifier automatically restarts. If Rectifier output voltage again exceeds the high voltage shutdown value within 5 minutes, the Rectifier shuts down and locks out. Manual restart is then required. If the Rectifier does not experience a high voltage condition within the 5-minute time-period, the restart circuit is reset.

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If two or more Rectifier are installed in a shelf, or if the shelf is paralleled with other Rectifier Mounting Shelves, only the Rectifier causing the high voltage condition shuts down.

2) **Backup:** If Rectifier output voltage exceeds a second (non-adjustable) value, the Rectifier shuts down and locks out regardless of load. Manual restart is then required.

- **Over-Temperature Protection:** The Rectifier provides overtemperature protection by derating output power and recovers automatically.
- **Hot Swappable:** The Rectifier is designed to be plug-and-play. The Rectifier can be inserted or removed from a live DC power system with no damage. When the Rectifier is plugged into the system, the system output voltage will not be affected.
- **High Temperature Alarm:** Each Rectifier continuously monitors the ambient temperature surrounding the power conversion circuit. If this temperature exceeds a preset non-adjustable value, local and extended Rectifier Fail alarms are activated. The alarms will automatically be removed when the ambient temperature surrounding the power conversion circuit decreases to below a preset non-adjustable value.
- **Cooling:** Each Rectifier Module contains a fan for front-to-back force air-cooling.

  a) **Fan Fault Protection:** The Rectifier Module shuts down and its alarm indicator (red) flashes if the fan fails. Fan failure is detected and reported to Controller. The fans are field replaceable.

  b) **Fan Control:** Fan speed is continuously variable. When input voltage is within normal range, the built-in processor adjusts fan speed according to the Rectifier Module's internal temperature and output power. For example, a higher temperature or output power increases the fan speed. This feature can be disabled via the controller, allowing the fan to run at full speed regardless of temperature.

- **Paralleling:** This Rectifier may be connected in parallel with any Rectifier of the same polarity and adjusted to the same output voltage.
- **Output Current Walk-In:**

  a) **Normal Start:**

  - Start up time, defined as beginning at AC switch on and ending when full output power has been reached, consists of two time intervals, the delay period and the output voltage rampup period.
  - During the delay period the output voltage will be zero.
  - Start up time (AC on, till full power): ≤ 5 seconds.
  - Output voltage ramp up period, t: 50 ≤ t ≤ 150 ms.
    (10% to 90% of full power)
  - The Rectifier will not suffer any damage, when subjected to repetitive AC switch on / switch off operations.

  b) **Current Walk-In (if enabled via Controller):**

  - 90% load in > 8S, 100% load in < 124s.
  - According to Telcordia GR-947-CORE, R3-19.

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- **Communication Failure:** The Rectifier's protection indicator (yellow) will flash should it experience a communication failure. The failure information will be reported to the Controller and the Controller will process the failure accordingly. During a communication failure, in order to protect the battery, the Rectifier output voltage will automatically be adjusted as follows. When used with the SCU+ Controller, Rectifier output voltage goes to a default value (53.5 V, which can be modified using the SCU+ Controller). When used with the ACU+ Controller, Rectifier output voltage goes to the ACU+ float voltage setting (this setting is stored in the Rectifier). The Rectifier will revert to normal operation once normal communication is restored.
- **Rectifier Output Current Imbalance:**

  a) When the average current of all Rectifier Modules is greater than 20% of full rated current, and the difference between local Rectifier Module current and average current is greater than 16% of full rated current, the yellow protection indicator will illuminate.

  b) When the average current of all Rectifier Modules is greater than 10% of full rated current, and local Rectifier Module current is less than 1.5% of full rated current, then the red fault indicator will illuminate.

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- **Monitoring Function:** The Rectifier has a built-in advanced DSP that monitors and controls the operation of the Rectifier. The DSP also communicates with the Controller in real time through the CAN bus. Table 1 lists the different commands and information exchanged between the Rectifier and the Controller.

Commands / signals that can be received by the Rectifier from the Controller.	**Information gathered by the Controller from the Rectifier.**
• Turn On/Off • Current Walk-in On/Off • HVSD (High Voltage Shutdown) Reset • Current Limit Adjustment • Voltage Regulation	• Input Voltage • Output Voltage • Output Current • Current Limit Setting • Temperature • Over Voltage Setting • On/Off Status • Fault Alarms, such as: HVSD Fan Fail • Protection Alarms, such as: Input Voltage Protection Inner DC Bus Voltage Protection High Temperature Protection • Thermal Derating • AC Derating • AC Fail • Imbalanced Output Current • Address • Code • Date • Software Version • Hardware Version

Table 1
Exchange of Information between Rectifier and Controller

- **External Control Circuits:** Provided via the associated Controller. Refer to the separate Power System documentation for a complete description of available external control circuits.
- **External Alarm Circuits:** Provided via the associated Controller. Refer to the separate Power System documentation for a description of available external alarms.

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Mechanical Specifications

- **Dimensions:**
  - **a) Millimeters:** 132.0 (Height) X 85.3 (Width) X 287.0 (Depth)
  - **b) Inches:** 5.20 (Height) X 3.36 (Width) X 11.3 (Depth)
- **Weight:** 3.5 kg (7.7 lbs).
- **Indicators:**
  - **a)** Power (Green)
  - **b)** Protection (Yellow)
  - **c)** Alarm (Red)

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OPERATION

AC Input Protection Device Requirements/Recommendations

Refer to the system documentation supplied with the system the rectifier is installed in.

Local Indicators

Location and Identification: Refer to Figure 12.

Description: There are three (3) indicators located on the Rectifier's front panel. The functions of these indicators are as shown in Table 2.

Note: *DC voltage must be present at the Rectifier output terminals, (from battery or an operating Rectifier) for local indicators to illuminate.*

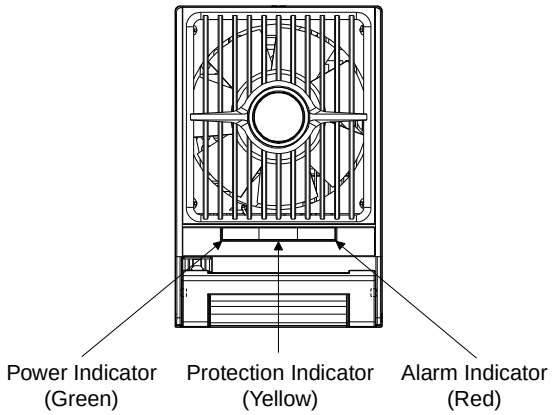

Figure 12
Local Indicator Locations

Indicator		Normal State	Alarm State	Alarm Cause
⏻	Power (Green)	On	Off	No input voltage. Internal input fuse open.
			Flashing	The Rectifier Module is being identified by the Controller.
🔔	Protection (Yellow)	Off	On	AC input under/over voltage. PFC output under/over voltage. High temperature. Moderate load sharing imbalance.
			Flashing	Loss of communication with controller.
🔔	Alarm (Red)	Off	On	Severe load sharing imbalance. Rectifier Module output disabled for any reason, including overvoltage shutdown and internal output fuse open. Rectifier addresses contradictory.
			Flashing	Faulty fan (Rectifier Module shuts down).

Table 2
Local Indicators

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Rectifier High Voltage Shutdown and Lockout Restart

Remove the rectifier, wait 30 seconds or more (until the LEDs on the rectifier extinguish), then re-insert the rectifier.

The rectifier(s) can also be restarted from the ACU+ LCD or WEB Interface menu (via the Rectifier Reset command, found in the Manual menu in the LCD menus or under the Rectifier Control Tab in the WEB Interface).

Installing Rectifiers

The Rectifier is hot swappable. It can be installed with the system operating.

Warning: To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a module. NEVER hold the handle in the closed position when installing a module into a shelf.

Procedure

1) Place the Rectifier into an unoccupied mounting slot without sliding it in completely.
2) Click the Rectifier handle in order to pop it forward out of the Rectifier's front panel (this will also retract the latch mechanism located on the underside of the Rectifier). Refer to Figure 13 for latch mechanism illustration.
3) Push the Rectifier completely into the shelf.
4) Push the handle into the front panel of the Rectifier. This locks the Rectifier securely to the shelf.
5) Repeat the above steps for each Rectifier being installed in the system.
6) After the Rectifiers are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them.
7) Certain functions (i.e. rectifier current limit, rectifier addressing) may require adjustment when adding or replacing a Rectifier Module. Refer to the Power System documentation for instructions.

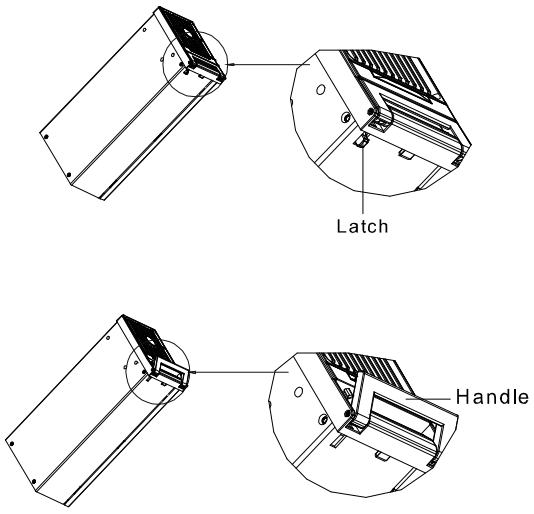

Figure 13
Installing a Rectifier

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TROUBLESHOOTING AND REPAIR

Troubleshooting

Rectifier Current Sharing Imbalance

When multiple Rectifiers are operating in parallel and the load is greater than 10%, if the current sharing imbalance among them is greater than 3%, check if the Rectifier is properly seated in the shelf.

If the current sharing imbalance still persists following the verification suggested above, replace the Rectifier exhibiting the current imbalance.

Rectifier Fault Symptoms and Troubleshooting

The fault indicators that can be displayed by the Rectifier are as follows. Refer to Table 3 for a list of possible causes and corrective actions.

- Power Indicator (Green) OFF
- Protection Indicator (Yellow) ON
- Protection Indicator (Yellow) Flashing
- Alarm Indicator (Red) ON
- Alarm Indicator (Red) Flashing

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Symptom		Possible Cause(s)	Suggested Action(s)
	Power Indicator (Green) Off	No input voltage.	Make sure there is input voltage.
		Internal input fuse open.	Replace the Rectifier.
	Protection Indicator (Yellow) On	AC input voltage outside the normal range.	Correct the AC input voltage to within the acceptable range.
		PFC over-voltage.	Replace the Rectifier.
		Moderate load sharing imbalance.	Replace the Rectifier.
		Rectifier not inserted into the slot completely.	Remove and properly insert the Rectifier.
		Rectifier over-temperature protection, which could be caused by:	
		1. Fan rotor blocked.	1. Remove any object that may be blocking the fan.
		2. Ventilation blocked (inlet or outlet).	2. Remove any object that may be blocking the inlet or outlet.
		3. Ambient temperature too high or Rectifier inlet too close to a heat source.	3. Lower the ambient temperature or relocate the heat source.
	Protection Indicator (Yellow) Flashing	Rectifier communication failure.	Check the communication cables. Remove and properly insert the Rectifier.
	Alarm Indicator (Red) On	Output over-voltage shutdown. Severe load sharing imbalance. Internal output fuse open.	Remove the Rectifier, wait 30 seconds or more (until the LEDs on the rectifier extinguish), then re-insert the Rectifier. If Rectifier fails to start or shuts down again; replace the Rectifier.
	Alarm Indicator (Red) Flashing	Fan not operating (Rectifier shuts down).	Replace the fan.

Table 3
Rectifier Troubleshooting

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Replacement Procedures

Rectifier Replacement

Danger: Take care when removing a Rectifier that was in operation, as Rectifier surfaces could be very hot.

Warning: To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a module. NEVER hold the handle in the closed position when installing a module into a shelf.

The Rectifier is hot swappable. It can be removed and installed with the system operating.

Procedure

1) Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any alarms associated with this system while this procedure is performed.
2) On the Rectifier to be removed, click the Rectifier's handle in order to pop it forward out of the Rectifier's front panel. This will retract the latch mechanism located on the underside of the Rectifier and thus unlock the Rectifier from the shelf. Refer to Figure 13 for latch mechanism illustration.
3) Slide the Rectifier out by pulling forward.
4) Place the replacement Rectifier into the mounting slot without sliding it in completely.
5) On the replacement Rectifier, click the Rectifier's handle in order to pop it forward out of the Rectifier's front panel (this will also retract the latch mechanism located on the underside of the Rectifier).
6) Push the Rectifier completely into the shelf.
7) Push the handle into the front panel of the Rectifier. This locks the Rectifier securely to the shelf.
8) Certain functions (i.e. rectifier current limit, rectifier addressing) may require adjustment when adding or replacing a Rectifier Module. Refer to the Power System documentation for instructions.
9) After the Rectifiers are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them. Verify that the Rectifiers are operating normally.
10) Enable the external alarms, or notify appropriate personnel that this procedure is finished.
11) Ensure that there are no local or remote alarms active on the system.

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Rectifier Fan Replacement

Each Rectifier uses a fan (P/N 32010086 for 1R483200 rectifier module. P/N 32010109 for 1R483200E and 1R483500E rectifier module) for cooling. If fan replacement should become necessary, perform the following procedure.

Refer to Figure 14 as this procedure is performed.

Caution: ***In a system with NO redundant Rectifier, battery must have sufficient reserve to power the load(s) while the Rectifier is removed for fan replacement.***

Note: *When performing any step in this procedure that requires removal of existing hardware, retain all hardware for use in subsequent steps.*

Procedure

1) Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any alarms associated with this system while this procedure is performed.
2) Remove the Rectifier from the shelf. Refer to a previous procedure for step-by-step instructions.
3) Place the Rectifier Module on a static-safe work surface. Connect an approved grounding strap to your wrist for the remainder of this procedure.
4) On this Rectifier, loosen the three (3) screws on the Rectifier front cover and remove the cover.
5) For proper orientation of the new fan, observe the location of the fan wires and the air flow arrows on the old fan.
6) Unplug the power cable of the old fan and remove the fan.
7) Plug the power cable of the new fan and place the new fan in the space vacated by the old fan. Ensure the fan wires and air flow arrows match the orientation of the old fan.
8) Position the Rectifier front cover back into place and secure with the screws previously removed.
9) Replace the Rectifier into the shelf. Refer to the previous procedure for step-by-step instructions.
10) When the fans start, check to ensure that each is providing front-to-back airflow. If air direction is wrong, immediately remove the Rectifier Module from the shelf. Repeat previous steps to check fan orientation, and correct as necessary. Reinstall the Rectifier Module and again check for proper airflow.
11) Enable the external alarms, or notify appropriate personnel that this procedure is finished.
12) Ensure that there are no local or remote alarms active on the system.

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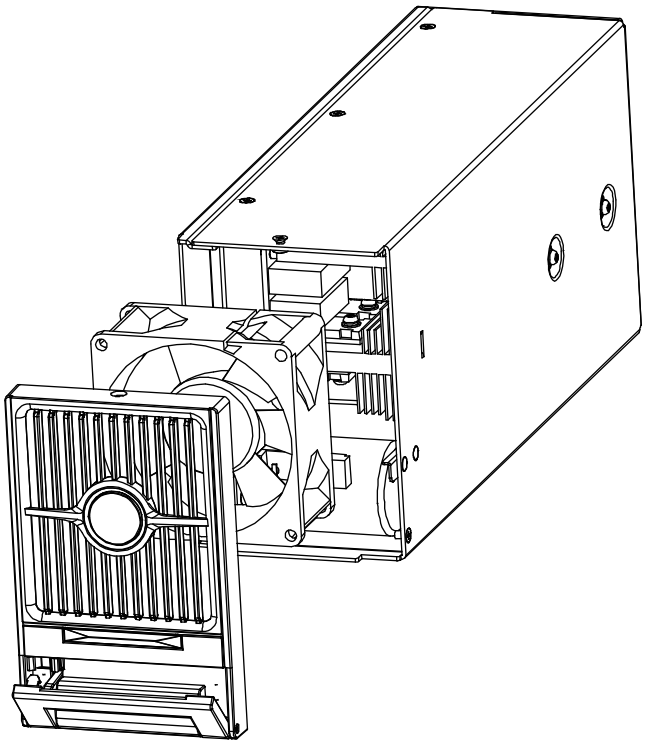

Figure 14
Rectifier Fan Replacement

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REVISION RECORD

Issue	Change Number (ECO)	Description of Change
AA	LLP214213	New
AB	LLP214923	Communication Failure description updated for when used with an ACU+ Controller.
AC	LLP216644	Correct wrong content of GBB rectifier fan replacement PNs.
AD	LLP216539	Typical input data updated.
AE	LLP217095	Items 1) and 2) added to the “Thermal Power Limiting” description under “Standard Features”.
AF	LLP217311	HVSD Restart instructions updated.
AG	LLP217962	Corrected Typical Input Data for 1R483500E.

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Emerson Network Power
Energy Systems, North America
4350 Weaver Parkway, Warrenville, IL 60555
Toll Free: 800-800-1280 (USA and Canada)
Telephone: 440-246-6999 **Fax:** 440-246-4876
Web: EmersonNetworkPower.com/EnergySystems
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